Update on sensitivity study for $B^- \to \Lambda \bar{p} \nu \bar{\nu}$

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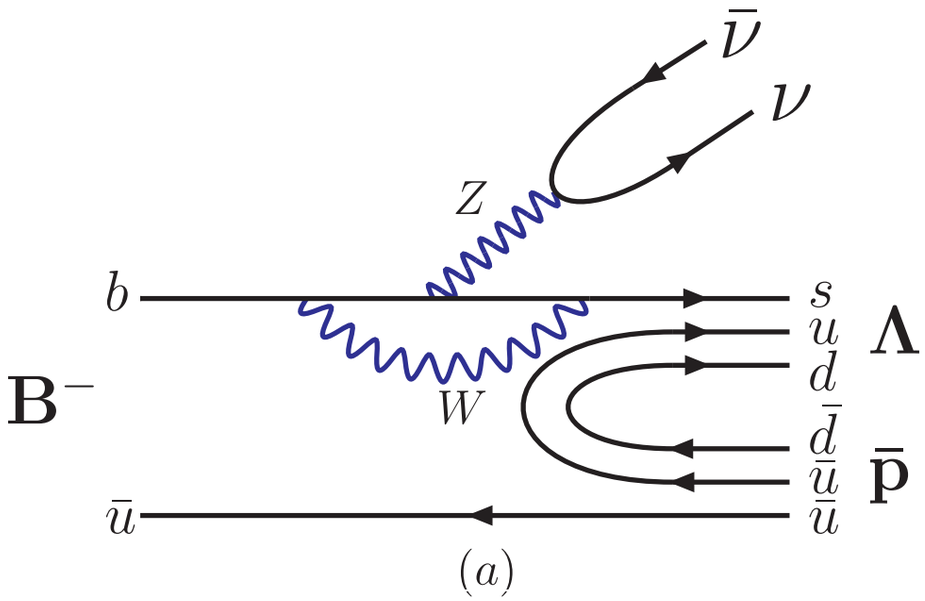
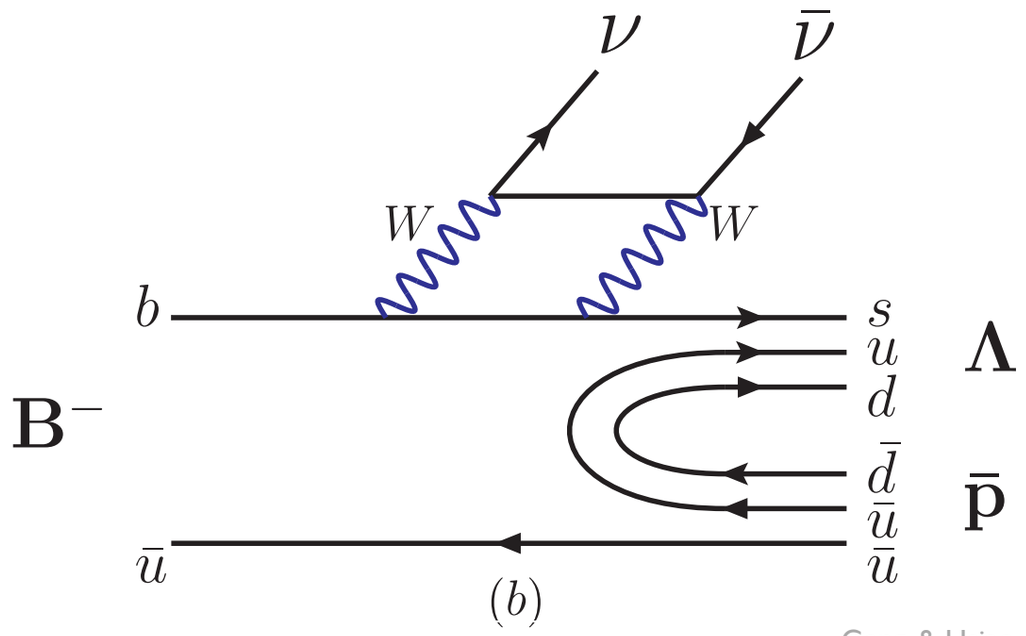
WG1 - (Semi-)Leptonic and Missing Energy Decays Meeting
2nd May 2018

Details and motivation





Geng, & Hsiao

C.Q. Geng, Y.K. Hsiao.
Phys. Rev. D 85 (2012) 094019

Predict $\mathcal{B}(B^- \to \Lambda\bar{p}\nu\bar{\nu})$ = (7.9 ± 1.9) x 10^{-7}

- Rare decay (suppressed by the standard model)
- New physics potentially hiding in loops - will affect branching fraction
- Amenable to further study: angular asymmetries, T-odd observables *etc.*

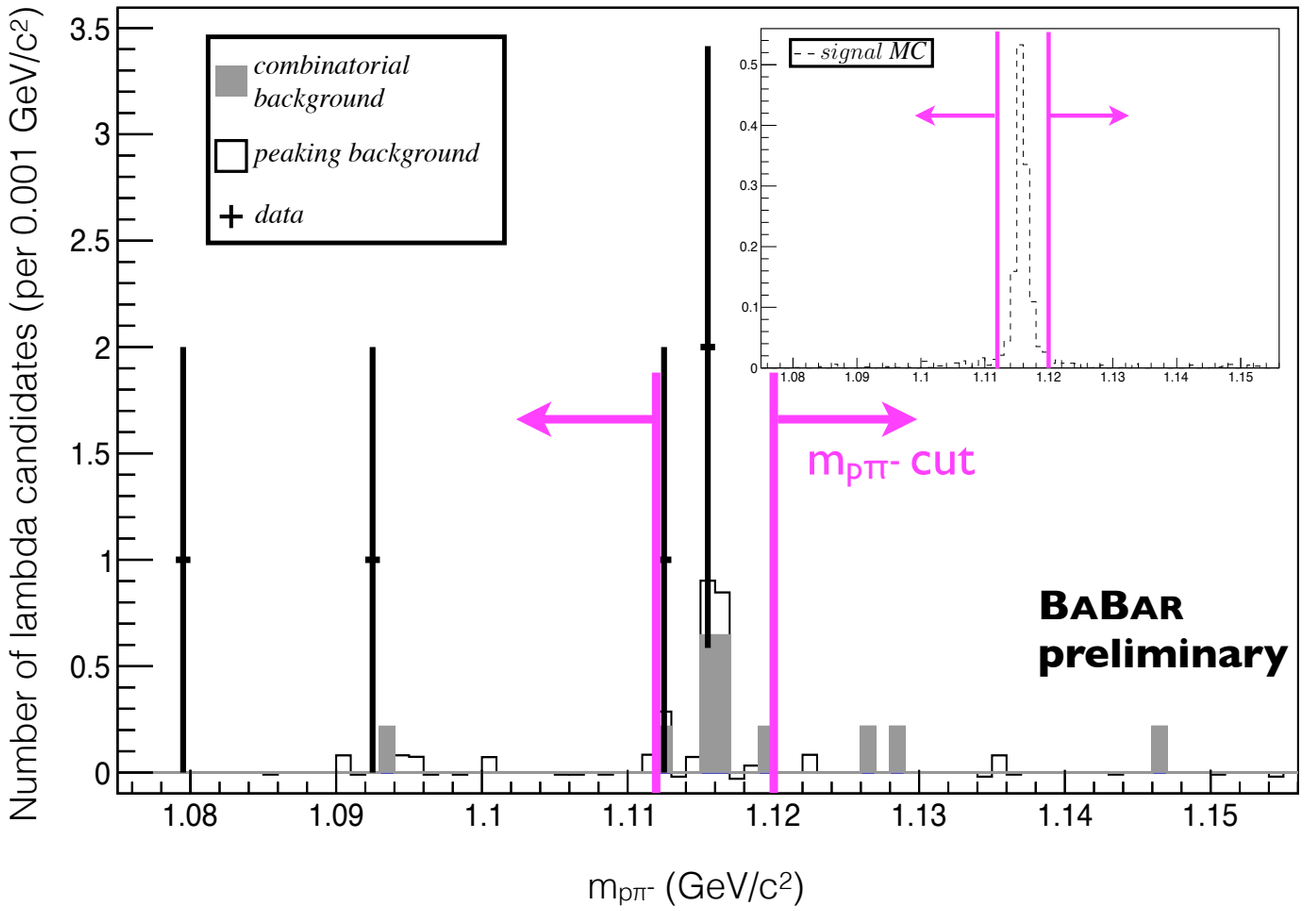
$B^- \to K^-\nu\bar{\nu}$

- Predicted: (4.5 ± 0.7) x 10^{-6} (J. High Energy Phys. 2009, 022)
- Measured:

BABAR (hadronic): <3.7 x 10^{-5} (Phys. Rev. D 87 (2013) 112005)
BABAR (semi-leptonic): <1.3 x 10^{-5} (Phys. Rev. D 82 (2010) 112002)
Belle (hadronic): <5.5 x 10^{-5} (Phys. Rev. D 87 (2013) 11110)

BaBar result

- Presented at Lake Louise 2018: https://indico.cern.ch/event/531125/contributions/2851789/



Data in signal region: 3 events

Final background estimate:
2.3 ± 0.7(stat.) ± 0.6(sys.)

Final signal efficiency:
(3.42 ± 0.08(stat.) ± 0.80(sys.)) x 10^{-4}

- First ever measurement of $B^- \to \Lambda\bar{p}\nu\bar{\nu}$. Results:

  BF central value: (0.4 ± 1.1(stat.) ± 0.6(sys.)) x 10^{-5}
  BF upper limit at 90% confidence level: 3.0 x 10^{-5}
  (Compare theory: (7.9 ± 1.9) x 10^{-7})

- No observation of signal or New Physics.

FEI and skimming

- Use MC9:
  - SigMC: MC9, 10 M events, phase3, Ups(4S), BGx1.
  - Generic background available in large numbers and (being) skimmed.

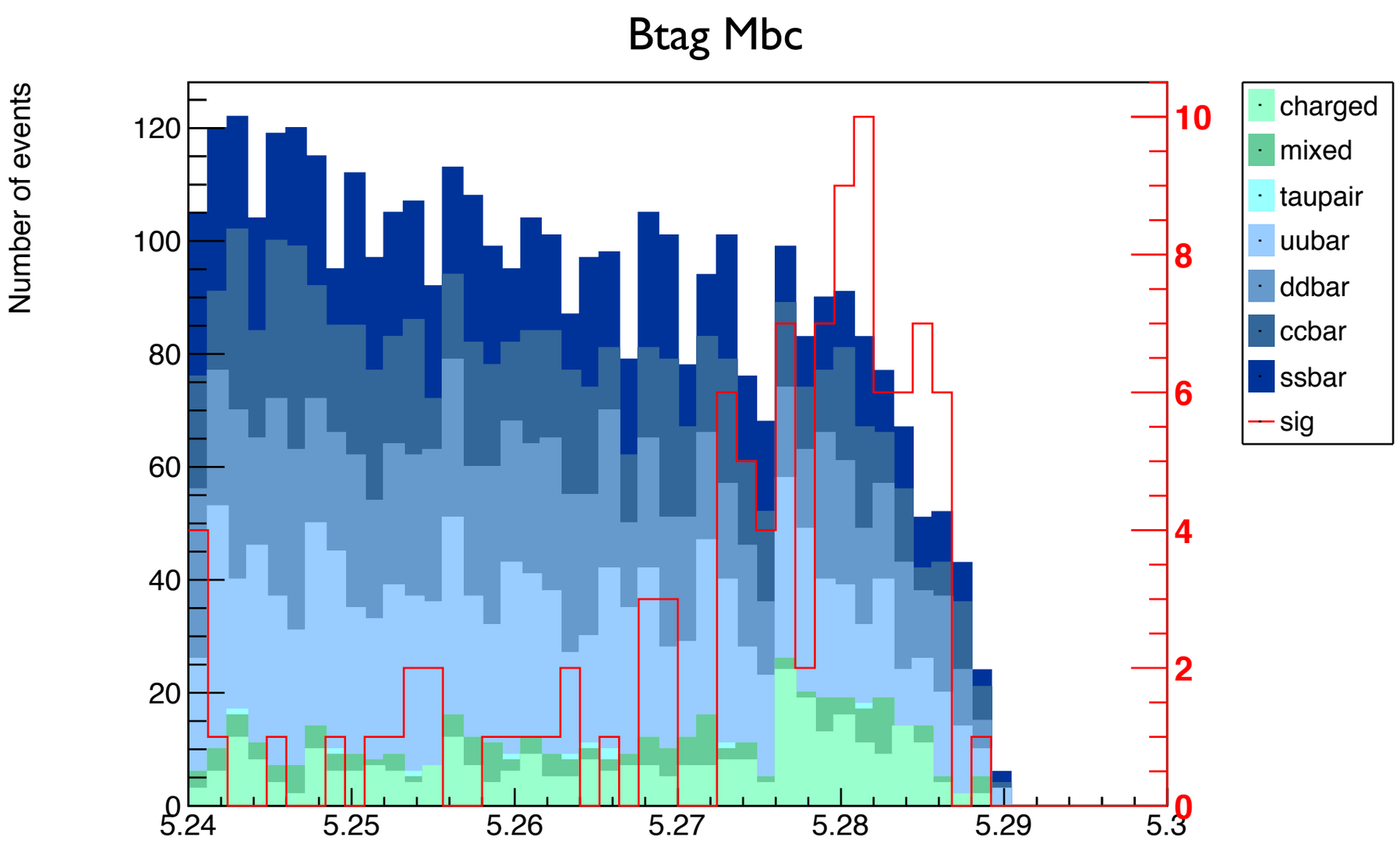
- Run MC through FEI (hadronic charged only) plus "skim" cuts:

<u>Central FEI skim cuts</u>
Mbc > 5.24 GeV
|deltaE| < 0.200 GeV
signal probability > 0.001

<u>Signal-specific/other cuts</u>
total number of tracks in event before FEI <= 10 (FEI can't reco Btags from >7 tracks)
missing energy > 0 (neutrinos)
remaining tracks in event after FEI == 3 (Lambda(p pi-)pbar)
if >1 Btag candidate in an event, keep candidate with highest signal probability

FEI and skimming

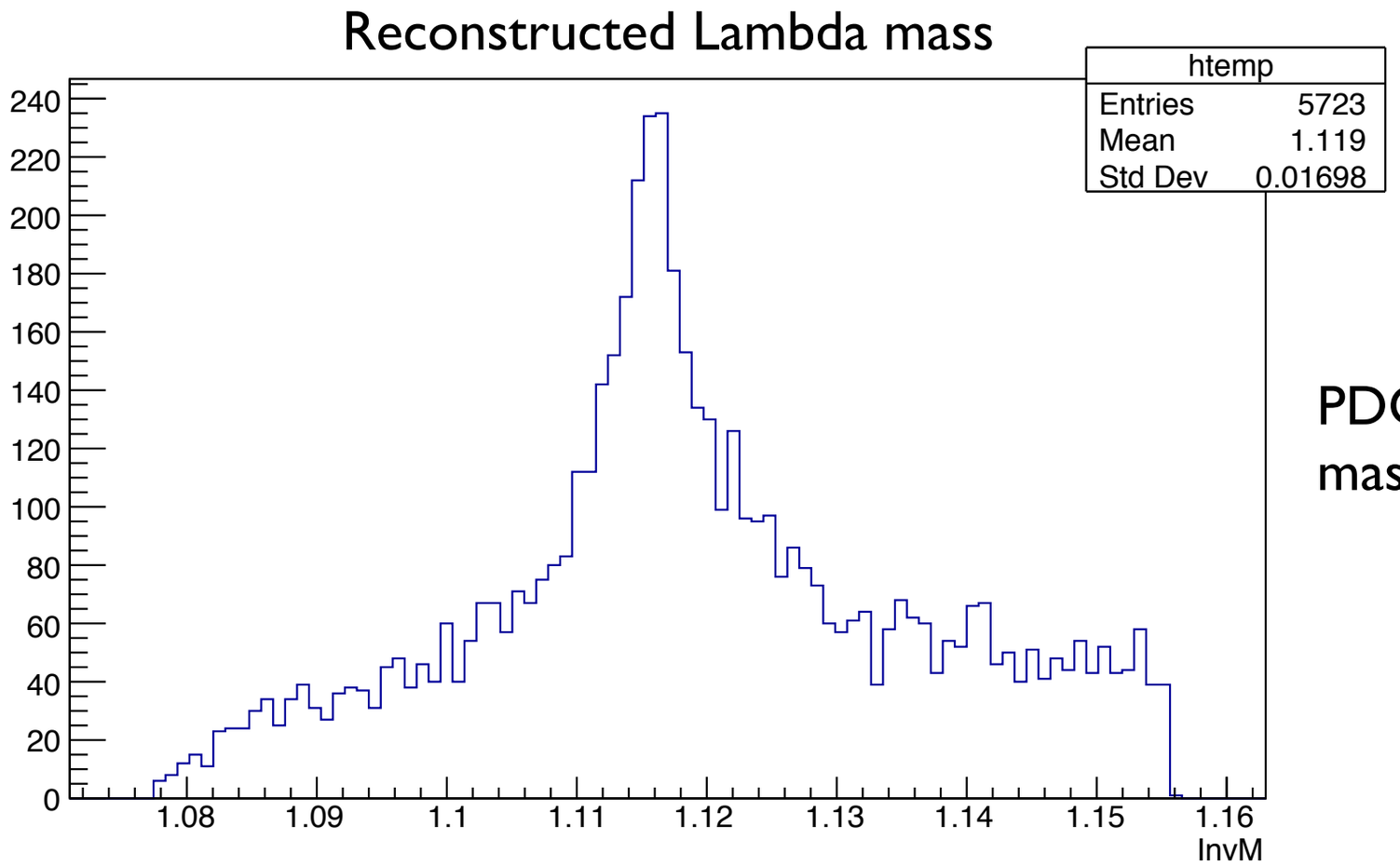
- Btag reconstruction using FEI and skim cuts on MC9, O(100,000) events for each event type:



Lambda reconstruction

· Reconstruct lambdas from PID'ed proton and pion candidates (95% selection efficiency in both cases). If >1 lambda candidate, choose one with best significance of distance relative to IP.

· From 150,000 sigMC events after FEI, but no tight Btag cuts imposed yet:



PDG Lambda
mass = 1.116 GeV

· Lambda reco at Belle2: 10-15% lower efficiency and 2x higher background than Belle, believed to be due to differences in pion tracking:
confluence.desy.de/x/dyWdAw → LambdaFindingBelle&BelleII.pdf

Plans and outlook

Immediate next steps in analysis

- Continuum suppression.
- Cut out events with large non-Btag ECL energy deposits.
- Scale-up analysis beyond O(100,000) events per MC type, i.e grid processing.

Longer-term plan

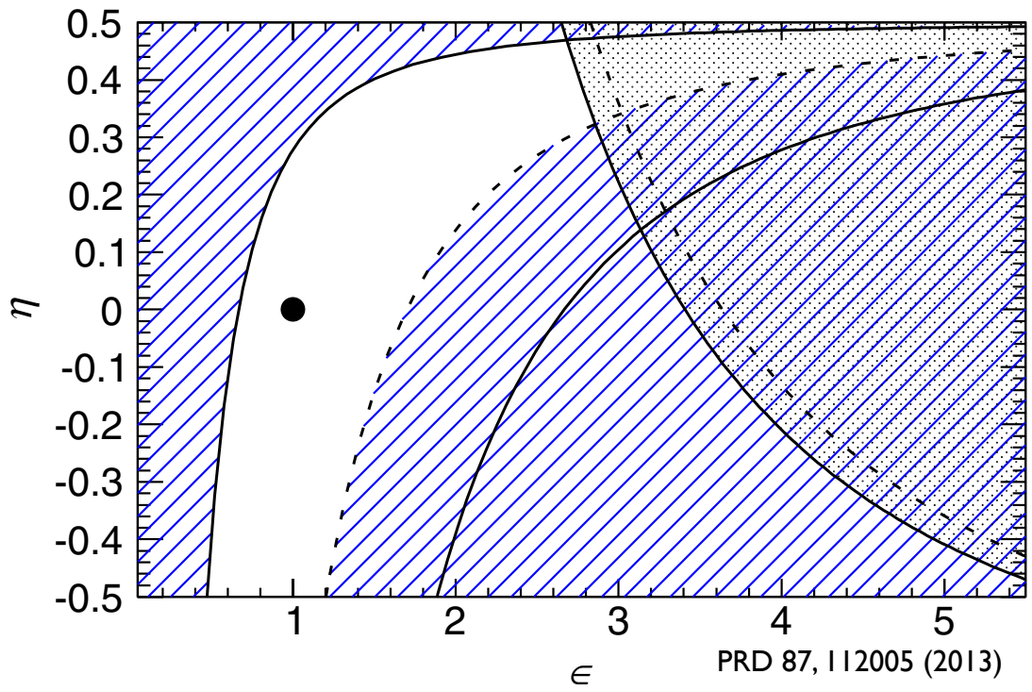
- Aim to complete an MC-only sensitivity study in a few months.

FEI skims

- Mostly available (>80% complete) and in-principle usable for analysis.
- FEI MC9 trainings released yesterday, central skims use MC7 training.
- Analysts need to skim their own signal MC anyway.

New Physics

- Branching fraction measurement can provide constraints on Wilson coefficients for left- and right-handed weak currents, as already done by BaBar B -> Knunu analyses:



PRD 87, 112005 (2013)